No. 94-2003

In The

Supreme Court of the United States

October Term, 1995

LOTUS DEVELOPMENT CORPORATION,

Petitioner,

v.

BORLAND INTERNATIONAL, INC.,

Respondent.

On Writ Of Certiorari
To The United States Court Of Appeals
For The First Circuit

BRIEF AMICUS CURIAE OF ECONOMICS PROFESSORS AND SCHOLARS IN SUPPORT OF RESPONDENT

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I. INTEREST AND IDENTITY OF THE AMICI

Amici are professors at Harvard University, Stanford University, Columbia University, the University of California, and other major universities, and other economic scholars who teach and write on economic issues. The economic conditions that prevail in markets such as the one before the Court in this case are subjects of intense interest and research among academic economists. Indeed, a number of amici have written scholarly papers addressing the application of intellectual property protection generally, and copyright law specifically, to "network" markets of the type at issue here. Amici do not represent either party in this action, and offer the following views on this matter in the public interest.[1] The parties have consented to the filing of this brief.

II. SUMMARY OF ARGUMENT

Intellectual property policy balances increased incentives for innovation against the harms from monopoly. Patent law confers relatively strong protection but requires evidence of significant novelty, utility, and non-obviousness. Copyright law does not demand so significant an innovation, but traditionally protects only

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[1] None of the amici listed in Appendix A are being compensated in any way for the work on this brief. The signatories to this brief exercised complete control over its editorial contents. Respondent Borland International, Inc. helped to defray the costs of preparation of this brief. One of the primary authors of this brief has performed a small amount of consulting services to Borland in the past.

"expression" for which there exists close economic substitutes.

In computer software, however, as users invest in training, the creation of data files, and the creation of macros, all based on the interfaces of the software they are using, and as more users adopt a particular interface, what were initially arbitrary choices in the design of an interface may become compelling choices. Alternatives that were initially close creative substitutes do not remain close economic substitutes. Thus, if copyright protects an interface, it may confer substantial monopoly power and foreclose subsequent innovation.

Such a monopoly may be an appropriate reward if the entrant's product is highly innovative, and amici do not advocate denying protection to successful software products. But in the case of software interfaces, the economic dynamics may confer this reward even if the product is not highly innovative. The monopoly power results not from the superiority of the copyright holder's creation, but from the accretion of users' investments. Thus, amici believe that uncritical copyright protection for interfaces in computer software is dangerous, and on balance undesirable when these economic dynamics prevail.

III. ARGUMENT

A. Intellectual Property Policy Embodies an Economic Trade-off

1. Monopoly Power Is Generally Harmful

Economic analysis and experience alike teach that, in general, monopoly is harmful, for a variety of reasons. A single entity that controls a market may, through avarice or error, make inefficient choices; in consequence consumers suffer and have no recourse. Protected from competition, the monopoly may become wasteful. Would-be competitors and subsequent innovators may be stymied or handicapped; in the case of a legally-protected monopoly, their competitive efforts may be distorted to avoid infringing the monopoly. And – the classic pricing inefficiency of monopoly – economic value is destroyed when the seller charges prices above cost so that buyers are harmed by more than the seller benefits.

2. Intellectual Property Policy Tolerates These Harms to a Limited Extent, in Order to Reward Innovation

Such inefficiencies result even when the monopoly is granted for good reason, as is the case for much intellectual property protection. Competition in exploiting an invention would be much preferable to monopoly in exploiting the same invention, for all the above reasons, among others. But we must also take into account the incentives to invent or to create in the first place. Especially if imitation is cheap and effective, as is the case with literal copying of software "code," unrestrained

competition in exploiting a creation may greatly reduce these incentives.

Therefore, economists see intellectual property law as embodying a trade-off: it should aim to confer just enough reward to encourage desirable innovation without creating unnecessary monopoly, and should protect in ways that minimize any incidental harm caused by monopoly. Substantial monopoly power should not be granted for creations that are not significantly innovative.

3. *When (Close) Creative Alternatives Are (Close) Economic Alternatives, Copyright Does Not Confer Harmful Monopoly Power*

Patent protection requires a showing of novelty, utility and non-obviousness. Copyright protection lacks these requirements, and therefore risks conferring monopoly power where no substantially innovative contribution needs to be rewarded.

In the traditional realms of copyright, such risks have perhaps not been excessive. Since copyright traditionally protects "expressions" for which there are good alternatives, and not the underlying "idea," it does not normally confer substantial control over the entire market: Expression generally has substitutes in the traditionally creative sense, which will also be substitutes in the economic sense, limiting the copyright holder's control of economic markets.

This reassuring argument assumes that good substitutes at the time of creation remain effective substitutes and can later compete as such. It breaks down if initially

arbitrary choices, for which there are good alternatives, become economically compelling through market dynamics.

B. Software Market Dynamics Can Turn Arbitrary Choices Into Compelling Choices

The initial design choices in a computer software interface may well be largely arbitrary, in the sense that comparably good alternatives are available. However, as users acquire experience in using the product, invest in learning and in writing macros and creating files, and as more and more users adopt an interface, those alternatives may no longer be comparably good. Thus, because of the nature of users' behavior in computer software markets, initially arbitrary interface choices, for which comparably good alternatives were readily available, can become uniquely desirable for users and therefore also for competitors. For brevity we will say they become "compelling." This happens through two related economic processes that economists call "network effects" and "user switching costs."[2]

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[2] The process by which these two economic forces combine to make copyright protection over software interfaces socially harmful is spelled out in Kenneth Baseman, Frederick Warren-Boulton and Glenn Woroch, "The Economics of Intellectual Property Protection of Software: the Proper Role for Copyright," *StandardView* 3, June 1995.

1. *Network Effects*

The English language would look highly arbitrary from the viewpoint of a "language designer" worki¬g with a clean slate. From such a viewpoint, there are a plethora of alternatives, many equally good and, surely, some better. Yet, for instance, once hundreds of millions of Americans learn the English language, these alternatives are no longer comparable. For every user, the advantages of learning and using the language of her community outweigh any benefits of superior design (such as are sometimes claimed, for example, for Esperanto). The user values, above all, the ability to communicate and "interoperate" with other users. Through the subsequent cumulation of others' choices and learning investments, the initially arbitrary language has become compelling: users will favor it even if it is not particularly good.

The same forces operate in many economic markets; economists call these forces "network effects." The classic illustration of a network effect, which is also responsible for the name, is a telephone network: the value of phone service to any individual depends on how many other individuals are connected. More generally, a network effect is an economic force that makes a product more valuable to each user, the more other users own that product or a sufficiently compatible one. In addition to direct network effects such as the telephone example, "indirect" network effects may be created through greater supply of complementary products.

Network effects are important in software markets.[3] Users want to share data files and programs such as macros; they want to work on machines owned by others; they want access to a wide selection of complementary products (including third-party manuals, consulting services, training courses, and add-on software). Certain aspects of programs must be identical in order for users of different programs to share these network benefits; these aspects will predictably include "interfaces" and aspects of a program that define a language, such as a macro language.[4]

2. *User Switching Costs*

Software users invest in complementary products and services, and in creating files and programs. Consider two programs that incorporate different arbitrary choices in their interfaces – choices that are equally good from the users' point of view prior to purchase and use. Because of these different interface specifications, the user's investments in learning, file creation, *etc.* are difficult or costly to transfer from one program to the other. Even if the user would be indifferent between the two interfaces *ex ante*, once she has invested in one system, she will substantially prefer it because she would have to

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[3] The presence of network effects was accepted by the court for personal computer operating system software in *Apple Computer, Inc. v. Microsoft Corp.*, 717 F. Supp. 1428, 1431 (N.D. Cal. 1989).

[4] Amicus Brief of Computer Scientists Re Copyrightability of Computer Languages, *Lotus Development Corporation v. Borland International, Inc.*, December 1993, at 2 (J.A. 10).

replicate these investments in order to switch to the other.[5]

Because of users' reluctance to switch, alternative interfaces that were equally good at the time of initial design do not remain equal and are not equal from the point of view of software designers who must choose an interface specification at a later date. Consequently, a new program attempting to compete with an established program will find that the first one's initially arbitrary interface choices have become economically compelling.

3. *Network Effects and User Switching Costs Are Important in Software and in Spreadsheet Markets*

Network effects and user switching costs are very strong in the computer software industry. Developers are keenly aware of the importance of compatibility to users. They take pains to ensure that new versions of a software package are compatible with earlier versions, both to minimize their own customers' switching costs and to

[5] As an analogy, consider the potential for introducing competition in local telephone service. One issue in this area is whether a subscriber should have the right to keep her telephone number if she switches to a competing carrier. The user has "invested" by telling her friends her number and printing it on checks and stationery, for instance. If the local (currently regulated) monopoly telephone company had "copyright" over subscribers' telephone numbers, she would be much more reluctant to switch to a competing supplier. Each person's number was initially arbitrary as far as she was concerned, but is now valuable to her.

maximize their network effects. This lesson was convincingly driven home to Lotus when it launched the Release 2.0 version of its *1-2-3* spreadsheet that was not fully compatible with the previous 1A version.[6] Compatibility at the user interface is also crucial since users do not have to learn a new set of keystrokes nor to "unlearn" keystrokes which have become automatic. This is one reason that Borland's programs (and most other popular spreadsheet and word processing packages) often provide a "chameleon interface" that allows users to choose one familiar to them and avoid learning a new one, inefficiently replicating their investments.

In the case of spreadsheet software, it clearly became compelling for competitors to offer compatibility with Lotus *1-2-3*.[7] Econometric evidence confirms that users

[6] "Compatibility was at the top of the list [of product design issues]. We actually had an experience around compatibility with Release 2.0 which was not totally nourishing for [Lotus], and it was after the release of Release 2.0 and the subsequent release of 2.01 where the importance of compatibility was firmly stamped on everyone's forehead as the single, unifying concept that we had to manage from generation to generation of our products." Deposition of Jim P. Manzi, Chief Executive Officer, Lotus Development Corp., August 22, 1991, p. 174, J.A. 715.

[7] It was important for *Quattro* to be compatible with files and macros created with *1-2-3* so that users would not have to replicate their investments. The Appeals Court fully appreciated the value of compatibility to users: "Under the district court's holding, if the user wrote a macro to shorten the time needed to perform a certain operation in Lotus 1-2-3, the user would be unable to use that macro to shorten the time needed to perform that same operation in another program. Rather, the user would have to rewrite his or her macro using that other

express their preference for compatibility in their spreadsheet purchase decisions.[8]

To illustrate network effects and their impact on competition, consider a computer user who wishes to buy a spreadsheet program and has narrowed his choice to two competing spreadsheet products. The first product will give him access to a large selection of spreadsheet data files created by others using that product's data format: for instance, many publicly available government records use Lotus' data format. The second spreadsheet product has no such installed base, but has certain superior features desired by the prospective new user. He would prefer to buy the second product, but only if it can read the pre-existing data files which are based on the first product's format – in other words, only if it is compatible to that extent.[9]

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program's menu command hierarchy. This is despite the fact that the macro is clearly the user's own work product." *Lotus Development Corp. v. Borland International, Inc.*, 49 F.3d 807, 818 (1st Cir. 1995), Pet. App. at 20a.

[8] Neil Gandal, "Hedonic Price Indexes for Spreadsheets and an Empirical Test of the Network Externalities," *RAND Journal of Economics*, 25 (1994), 160-170 finds that "consumers are willing to pay a significant premium for spreadsheets that are compatible with the Lotus platform."

[9] Neil Gandal, "Competing Compatibility Standards and Network Externalities in the PC Software Market," *Review of Economics and Statistics*, November 1995, forthcoming, discusses these effects empirically in spreadsheet and database markets.

4. *Our Usage of the Term "Interfaces" Is Defined By Economic Properties*

Amici do not claim to know exactly which aspects of computer programs must be compatible in order for the programs to remain as competitive after the build-up of network effects and switching costs as they would be *ex ante*. In general, interface specifications must be compatible for this to occur. For convenience, therefore, we use the term "interface aspects" to mean those choices.

C. In the Presence of Network Effects and Switching Cost Dynamics, Copyright Protection May Confer Monopoly Power Even Absent Real Innovation

Whether or not network effects and switching costs limit competition depends crucially on whether or not vendors have proprietary control of the interfaces. If interfaces are public, competitors can make their products compatible, and users will be able to choose a program on the basis of its quality and price rather than on switching costs and installed base of users. If interfaces are protected by copyright, the copyright holder can prevent competitors from making their products compatible. In this way the intellectual property treatment of interfaces crucially affects the nature of competition.

If an established seller controls network effects, a competitor must either convince users that a new product will succeed broadly (as distinct from simply appealing to a particular user), or else persuade them that, despite the disadvantage in network effects, the product

improvement is so dramatic that they should switch anyway. Similarly, if existing users must bear switching costs (must replicate their private investments) in order to buy from a competitor, the competitor operates at a disadvantage. It is well recognized in economics and in competitive strategy that these effects provide an advantage and an opportunity for long-term profits to an incumbent, even absent any inherent superiority of its product.[10]

In this way the established product, even if not highly innovative, may acquire substantial monopoly control through the copyright protection of its interfaces. Such a result is contrary to what we understand to be the usual pattern of copyright, which provides narrow protection by protecting only "expression" and refusing to protect an "idea," and to the usual pattern of patent law, which confers potentially broad control as a reward for demonstrably innovative contributions. Those usual patterns make economic sense in terms of the intellectual-property tradeoff described above, unlike the outcome when copyright confers broad control with no showing of innovativeness.[11]

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[10] Michael Porter, *Competitive Strategy*, The Free Press, 1980, at 10 and 114 (and elsewhere); Marvin Lieberman and David Montgomery, "First- Mover Advantages," *Strategic Management Journal* 9 (1988), 41-58; Joseph Farrell and Garth Saloner, "Installed Base and Compatibility: Innovation, Product Preannouncements, and Predation," *American Economic Review* 76 (1986), 940-955.

[11] When copyright protection confers large rewards on interface creations that are not particularly innovative, two further dynamic inefficiencies arise. Firms may deliberately create incompatible interfaces in the hope of being the lucky focus of network effects, but meanwhile the market is inefficiently splintered among incompatible interfaces. And firms may race to introduce products prematurely – an incentive that may be partly responsible for the prevalence of "bugs" in new software releases.

D. Network Effects and Switching Cost Dynamics Amplify the Harm Caused by Monopoly

Monopoly power is likely to be particularly harmful in markets in which network effects and user switching costs are important. As with any monopoly, above-cost pricing will deter purchases by many potential users who value the product more than it costs to produce. Economic efficiency is thereby harmed in any market. But when network effects are important, there is an additional effect: those who do buy get a less valuable product as a result of the smaller network. Thus, where network effects are present, the ordinary pricing inefficiency of monopoly is likely to be amplified.[12]

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[12] See, for instance, Joseph Farrell and Carl Shapiro, "Standard Setting in High-Definition Television" *Brookings Papers on Economic Activity*, 1992, at 41-42, and Joseph Farrell, "Arguments for Weaker Intellectual Property Protection in Network Industries," *StandardView* 3, June 1995, 46-49. In principle the monopoly right holder could adopt "penetration pricing" and thus reward early purchasers for the benefits they provide to later users. Under this scheme prices start low and become higher as the product becomes established. More often, the tendency to "price skim" overwhelms any attempt at penetration pricing. The "price skimming" strategy is to set prices high initially to extract profits from users who value the product highly, and then gradually reduce price over time to make sales to other users. See Luis Cabral, David Salant and Glenn Woroch, "Monopoly Pricing with Network Externalities," forthcoming in *International Journal of Industrial Organization*.

The pricing inefficiency of monopoly is not the only concern, however. In computer software, cumulative innovation is important – developers of the next generation of software products benefit from the breakthroughs, and try to avoid the pitfalls, of their predecessors. Consequently, it is highly desirable that all comers be able to build on the existing state of knowledge.[13] In cumulative innovation markets, overly strong intellectual property protection may actually retard rather than encourage innovation; thus there may not be any social benefits from increased incentives for innovation to weigh against the social costs of monopoly distortions.[14]

IV. CONCLUSION

For the reasons given above, amici believe that economic efficiency argues strongly against *uncritical* protection of *interface* aspects of computer software. It is economically harmful to protect, through copyright's uncritical mechanism, an aspect of computer software that is initially arbitrary but then becomes compelling. As

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[13] *See* Brief Amicus Curiae of Computer Scientists, Section III B 2.

[14] William Landes and Richard Posner, "An Economic Analysis of Copyright Law," *Journal of Legal Studies*, XVIII, June 1989, 325, 348, argue that overprotection will reduce the number of products. Robert Merges and Richard Nelson, "The Complex Economics of Patent Scope," *Columbia Law Review*, 1990, and "On Limiting Or Encouraging Rivalry in Technical Progress: The Effect of Patent Scope Decisions," *Journal of Economic Behavior and Organization* 25 (1994), 1-24, describe how strong intellectual property protection has retarded cumulative innovation in a number of industries.

copyright law does not generally protect compelling "choices," amici urge the Court to find that the *initial* or *ex ante* arbitrariness of interface design means that it should not be granted broad protection. Rather, only those aspects of a software program whose value, if any, stems from their originality and quality should be protected. Those aspects whose potential value will be due to network effects or user switching costs should not be. On amici's understanding of the facts in this case, when Borland introduced *Quattro*, it undertook the extra effort to make its product compatible largely in order to avoid imposing switching costs on Lotus users who might switch to *Quattro* and to be on an equal footing in respect of network effects.

Intellectual property protection should reward software developers for their innovative contributions. For economic efficiency, these returns should encourage innovators to create software products in number and quality so as to maximize the overall well-being of users and creators jointly. This almost certainly involves a prohibition on literal copying of code. It may also involve protection of broader aspects of a software product, especially if the creation is in fact highly innovative (and we express no view here on whether Lotus' interfaces were). This may well involve large rewards for highly innovative products and we certainly do not advocate punishing winners. But protection of software should not *uncritically* protect aspects that confer substantial monopoly power over a significant market segment, as amici believe will be the case if interfaces such as program

menu commands are automatically protected by copyright.

Respectfully submitted,

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APPENDIX A
LIST OF SIGNATORIES TO THE BRIEF

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1. Joseph Farrell
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Joseph Farrell is Professor of Economics and Affiliate Professor of Business at the University of California, Berkeley. His teaching has included graduate level classes in industrial organization, microeconomics, and competitive strategy. He is (jointly) North American Editor of the Journal of Industrial Economics, and Associate Editor of The Economics of Innovation and New Technology. He has been a reviewer for the National Science Foundation, the National Academy of Sciences, and the Office of Technology Assessment on matters involving innovation and high technology. He has been a consultant for the US Department of Justice and for private firms in computer software and related industries. He has been a leader in developing the economic theory of compatibility standards and of user switching costs, and has published numerous academic articles on these subjects.

2. Glenn Woroch
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Professor Woroch is presently Lecturer and Director, Consortium for Research on Telecommunications Policy, Haas School of Business at the University of California, Berkeley. He received an M.A. in Statistics and a Ph.D. in Economics from Berkeley. He teaches industrial organization, regulation and microeconomics at Berkeley, and he has

previously taught economics at the University of Rochester and at Stanford University. He was also a research economist at GTE Laboratories. He is currently a member of the editorial boards of Information Economics & Policy and The Journal of Regulatory Economics, and a member of the board of directors of the International Telecommunications Society. He has consulted for the Departments of Energy and Commerce on economic and regulatory issues and regularly serves on industry committees. Besides publishing numerous articles on regulation, antitrust and industrial organization, he has recently published research on the economics of intellectual property protection of computer software.

[Additional Signatories – In alphabetical order]

3. Kenneth J. Arrow
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Professor Arrow has also been a member of the faculty at the University of Chicago and Harvard University and a Research Associate of the Cowles Commission for Research in Economics. He received his Ph.D. in Economics from Columbia University in 1951. He has published papers and books in the fields of social choice, general economic equilibrium, medical care, and the economics of information and innovation. He has been president of several learned societies and has received several honorary awards, including the Nobel Memorial Prize in Economic Science in 1972.

Statement: I agree fully with the general principles of this brief, especially the need to insist on a high degree of novelty for recognizing copyright

protection in interfaces. I am not acquainted with the specific facts in this case and take no stand about any of them.

4. W. Brian Arthur

Professor Arthur is Morrison Professor of Economics at Stanford and Citibank Professor at the Santa Fe Institute. He has written numerous articles and a book (Increasing Returns and Path Dependence in the Economy, University of Michigan Press, 1994) on the dynamics of network effects. He is a Fellow of the Econometric Society and was awarded the Schumpeter Prize in 1990.

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Sanford V. Berg, Ph.D., is Distinguished Service Professor in the Department of Economics at the University of Florida. He is also the Florida Public Utilities Professor and the Director of the Public Utility Research Center where he organizes conferences and workshops on regulatory issues. In addition, he has served as a consultant to various private and public organizations including state regulatory commissions, corporations, the Congressional Office of Technology Assessment, and the World Bank. Presently, he is a project co-director of the Telecommunications Industry Analysis Project (TIAP). He was selected as the University of Florida Outstanding Undergraduate Teacher of the Year (1993). In 1994, he was the University's nominee for the Professor of the Year Award (Carnegie Foundation for the Advancement of Teaching). He has published widely on business and economics topics, including copyright protection, compatibility standards, and

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7. Paul A. David

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8. Nicholas Economides

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His fields of specialization and research include industrial organization, the economics of networks, especially of telecommunications and of information, the economics of technical compatibility and standardization, and the structure and organization of financial markets. He has published widely in the areas of networks, telecommunications, oligopoly, positioning of differentiated products, and on liquidity and the organization of financial markets and exchanges. He holds a Ph.D. and a M.A. in Economics from the University of California at Berkeley as well as a B.Sc. (First Class Honors) in Mathematical Economics from the London School of Economics. He has previously taught at Columbia University (1981-1988) and at Stanford University (1988-1990). He is editor of the International Journal of Industrial Organization, and associate editor of Journal of Regional Science. He is currently editing a special issue of the International Journal of Industrial Organization on Network Economics. His book,

"Communications Convergence: Economic Perspectives on Quality and Market Evolution," jointly written with Bob Dansby, is forthcoming from MIT Press and the American Enterprise Institute.

9. Aaron Edlin
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Professor Edlin is on the faculty of the economics department of the University of California at Berkeley. He received his A.B. in the science and policy program of the Woodrow Wilson School at Princeton University, and his Ph.D. in economics and J.D. in law from Stanford University. In research, he specializes in industrial organization, law and economics, and public economics. He teaches industrial organization and public economics.

10. Neil Gandal
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Professor Gandal received his Ph.D. in Economics from the University of California-Berkeley in 1989. One of his areas of expertise is the Economics of Compatibility and Standardization. He has published or co-authored a number of the papers in this area, including:

"Competing Compatibility Standards and Network Externalities in the PC Software Market," *Review of Economics and Statistics*, November 1995.

"Hedonic Price Indexes for Spreadsheets and an Empirical Test for Network Externalities," 1994, *RAND Journal of Economics*, 25: 160-170.

11. Jerry Richard Green
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Jerry Green is the John Leverett Professor in the University and the David A. Wells Professor of Political Economy in the Department of Economics. He joined the Harvard faculty in 1970, chaired the Economics Department from 1984 to 1987, and served as Provost of the University from 1992 to 1994.

Professor Green is a Fellow of the Econometric Society and served on its Council from 1988 to 1994. He is a Fellow of the American Academy of Arts and Sciences and has been an Erskine Fellow at the University of Canterbury, and a Guggenheim Fellow. He is an Oversees Fellow of Churchill College, Cambridge University. In 1980, he received the J.K.Galbraith Prize for excellence in teaching.

Professor Green chaired the National Science Foundation's Information Sciences Advisory Panel in 1980, prepared the Foundation's Ten-Year Outlook for the Social Sciences in 1983 and served on the National Academy of Sciences Panel on Taxpayer Compliance in 1984. He is a member of the Board of Trustees of the Beth Israel Hospital of Boston where he serves on the budget and finance committee and chairs the committee on conflict of interest policy. He has been an advisor to many universities and foundations.

Professor Green is known for his work on the theories of incentives, rational expectations, and behavior under uncertainty. He has contributed to a number of areas in applied economics, including tax policy, finance, health economics, higher education, and patent policy. He is the author of Incentives in Public Decision Making (with Jean-Jacques Laffont, 1978), Microeconomic Theory (with Andreu Mas-

Colell and Michael Whinston, 1995) and over eighty scientific articles.

12. Michael D. Intriligator
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Michael D. Intriligator is Professor of Economics at the University of California, Los Angeles (UCLA), where he is also Professor of Political Science, Professor of Policy Studies in the School of Public Policy and Social Research, and Director of the Jacob Marschak Interdisciplinary Colloquium on Mathematics in the Behavioral Sciences. From 1982 to 1992 he was Director of the UCLA Center for International and Strategic Affairs. He has been a member of the UCLA faculty since 1963, the year he received his Ph.D. in Economics at MIT working under Robert M. Solow. He teaches courses in economic theory, econometrics, mathematical economics, and international relations. His papers in economics are in the areas of economic theory, econometrics, health economics, and the transition to a market economy. He has published more than 100 journal articles and other publications and is the author of *Mathematical Optimization and Economic Theory* (Prentice-Hall, 1971) and *Econometric Models, Techniques, and Applications* (Prentice-Hall 1978, second edition with Ronald G. Bodkin and Cheng Hsiao, forthcoming, 1995). He is a Fellow of the Econometric Society, a member of the Council on Foreign Relations (New York) and the International Institute for Strategic Studies (London), and is listed in *Who's Who in America* and *Who's Who in Economics*.

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Louis Kaplow is a Professor of Law at Harvard Law School and a Research Associate at the National Bureau of Economic Research. He received his J.D. and Ph.D. (in economics) both from Harvard University. His teaching and research involve the application of economic analysis to law, with a specialization in competition policy. Among his writings in this area are an article on the relationship between intellectual property and competition policy and the text, Antitrust Analysis, co-authored with Phillip Areeda. Professor Kaplow also serves on the editorial board of a number of journals and as a referee for many of the leading economics journals that publish articles in this field. In addition, he has advised the Department of Justice and testified before Congress on issues pertaining to the appropriate relationship between intellectual property and competition policy.

14. Suzanne Scotchmer
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Professor Scotchmer was previously Associate Professor of Economics at Harvard University, and has been Visiting Professor at the University of Paris I, University of Toronto, and New School of Economics, Academy of Sciences, Moscow, Russia. In the last several years she has held research fellowships at Yale University (Olin Fellow) and Stanford University (Hoover National Fellow). She received her M.A. in Statistics from U.C., Berkeley in 1979 and her Ph.D. in economics from U.C. Berkeley in 1980. She has published widely on the economics of intellectual property law, economics of crime with

an emphasis on rules of evidence in the law, economics of tax evasion, cooperative game theory, club theory, and evolutionary game theory. Her research in the past has been supported mostly by the National Science Foundation, by also the Sloan Foundation, the Olin Foundation, the Harris Trust, and Phi Beta Kappa.

Among her editorial activities, she has served on the editorial board of two of the three journals of the American Economic Association, the *American Economic Review* and *Journal of Economic Perspectives*, and also on the editorial boards of the *Journal of Public Economics* (published at the London School of Economics) and *Regional Science and Urban Economics* (a North-Holland Journal). She referees for all the major economics and policy journals.

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